REMARKS

The Final Office Action mailed April 6, 2001, has been received and reviewed. Claims 1 through 44 are currently pending in the application. Claims 1 through 44 stand rejected. Applicant proposes to amend claims 1, 23, and 39, and respectfully requests reconsideration of the application as proposed to be amended herein. Alternatively, applicant proposes to amend the foregoing claims in order to present the claims in better form for consideration on appeal.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on Dixit et al. Article (IEDM '94) or U.S. Patent No. 5,998,296 to Saran et al. Taken With U.S. Patent No. 4,941,032 to Kobayashi et al.

Claims 1 through 44 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Dixit et al. Article (IEDM '94) or Saran et al. (U.S. Patent No. 5,998,296) taken with Kobayashi et al. (U.S. Patent No. 4,941,032). Applicant respectfully traverses this rejection, as hereinafter set forth.

M.P.E.P. 706.02(j) sets forth the standard for a Section 103(a) rejection:

> To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, **the prior art reference (or references when combined) must teach or suggest all the claim limitations.** The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). (Emphasis added).

The Applicant respectfully disagrees with the Office Action's assessment of the Dixit reference and the Saran patent. The Dixit reference teaches aluminum hole filling being achieved by conventional sputter deposition of an Al-Cu alloy to bridge the top of each hole metal, which leaves a void inside the hole. The wafer is then transferred under vacuum in a high pressure

chamber with radiant heaters and the bridged Al-Cu is forced into the holes by pressuring the chamber with argon. As illustrated in Figure 1 of the Dixit reference, this results in a forced external pressure that results in a deformation or inward extrusion of the aluminum bridge over the hole or via when the aluminum bridge fills the contact hole or via. As illustrated and described in the present application, it is exactly this type of deformation in the that the semiconductor assemblies and devices of the present invention intentionally avoids. (*See*, page 4, lines 5-7 and Figure 2 of the present application). Additionally, the Dixit reference teaches that a Ti/TiN barrier is sputter deposited at the bottom of the semiconductor and on top of the aluminum layer.

Independent claims 1, 23 and 39 recite a semiconductor assembly having a void-free, aluminum alloy-containing material within contact holes in an insulating layer, in direct contact with a substrate and having a nondeformed aluminum bridge over the contact holes. This product is created by depositing an aluminum material on an exposed surface of the insulating, heating the aluminum material to partially fill the holes, applying pressure to the aluminum material to fill the holes, depositing a different metal material over the contact holes and forming a homogeneous metal fill material in the contact holes. This process creates a different product than that contained in the Dixit reference. The present invention corrects for the deformations contained as a result of the Dixit reference product. As stated in the specification of the present invention on pages 4 and 5, this application alleviates the problems of void being formed inside each hole below the filled or bridged mouth. Significantly, as stated above, the present invention includes formation of an aluminum bridge over the hole or via that is <u>not deformed or extruded inwardly</u>. Additionally, the present invention eliminates the need for deposition of TiN, as taught in the Dixit reference, which helps conserve the target material composition. (*See,* page 9, lines 14 to 20 of the present specification). This results in semiconductor assemblies and devices having an aluminum alloy-containing material that is in direct contact with the underlying substrate and which does not require the existence of a TiN barrier therebetween. Thus, the present invention results in a semiconductor assembly or device having an aluminum alloy-

containing material in direct contact with a substrate and having a nondeformed aluminum bridge over the filled contact holes, which is designed to overcome the limitations of the Dixit reference. Accordingly, the Dixit reference merely recites the shortcomings of prior art structures and, thus, teaches away from the present invention.

Similarly, the present invention overcomes the limitations contained in the Saran patent. The Saran patent teaches first forming a fill metal layer over the semiconductor, forming a surface coating over the metal fill layer and then applying high pressure on the surface coating to force the fill metal into the opening. (*See* Saran, column 1, lines 55 to 61 and column 2, line 50 to column 5, line 5). After the formation of surface coating layer 32, pressure is exerted on the surface coating layer "forces the fill metal to descend into opening 20." (*Id.* at col. 3, lines 1-5). As a result, the Saran patent contains contacts that are deformed or extrude inwardly. The forced fill process of the present invention completely and evenly fills all of the contact holes unlike the Saran patent, thus creating a different and more advantageous product. Also, like Dixit and unlike the present invention, Saran teaches deposition of barrier/adhesion layers 22/24 and 52/54 between the fill metal layer (30 or 60) the substrate (18/48). Thus, the Saran patent teaches away from the present invention.

Applicant also disagrees with the Office Action's assessment of the Kobayashi patent. The Kobayashi patent teaches using an aluminum alloy as material for a metal electrode. Specifically, Kobayashi relates to amorphous silicon solar cells and pin type photosensors utilizing transparent conductive thin films that are specifically designed to avoid reduction of reflectivity. (*See*, Kobayashi at col. 1, lines 12-28, and col. 3, lines 21-26). Kobayashi specifically defines "semiconductor device" as "a solar cell, photosensor, photosensitive drum, thin film transistor, electroluminescent device, and the like . . . ." (*Id.* at col 4, lines 12-16). In fact, Examples 1-6 of Kobayashi are limited to description of glass substrates and solar cells. (*Id.* at cols. 5-6). Kobayashi fails to teach using the aluminum alloy within contact holes in an insulating layer, as claimed in the present invention. The aluminum alloy of the Kobayashi patent is used only as a metal electrode which can be electrically connected to a semiconductor.

In contrast, the formation of the homogeneous aluminum alloy of the present invention is formed within the contact holes or via of the wafer thus improving strength, stress migration and electromagnetic properties of the contact or vias. Because there are no contact holes in the structure of the Kobayashi patent, the Kobayashi patent actually teaches away from a semiconductor structure having a homogeneous aluminum alloy with an insulating layer. Therefore, there is no motivation in Kobayashi to combine any of its elements with the elements of the Dixit reference or the Saran patent particularly when a number of elements are non-existent therein and where the inventions are drawn to two different types of inventions having different functions and operation. To combine the references as the Office Action exhibits, is impermissibly relying on hindsight reconstruction. In view of the foregoing, applicants respectfully contend that the Dixit reference and Saran and Kobayashi patents fail to teach the elements contained in the claims of the present invention and thus do not qualify as 103(a) prior art.

Neither the Dixit reference, the Saran patent or the Kobayashi patent, either alone or in combination, teach or suggest all the claim limitations of independent claims 1, 23 and 39 of which claims 2-22, 24-28 and 40-44 subsequently depend upon. Therefore, reconsideration and withdrawal of the rejection of claims 1-44 under Section 103(a) are respectfully requested.

ENTRY OF AMENDMENTS

The proposed amendments to claims 1, 23, and 39 above should be entered by the Examiner because the amendments are supported by the as-filed specification and drawings and do not add any new matter to the application. Further, the amendments do not raise new issues or require a further search. Finally, if the Examiner determines that the amendments do not place

the application in condition for allowance, entry is respectfully requested upon filing of a Notice of Appeal herein.

CONCLUSION

Claims 1-44 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, he is respectfully invited to contact Applicant's undersigned attorney.

Respectfully Submitted,

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Enclosure: Version With Markings to Show Changes Made

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

1. (Twice amended) A semiconductor device structure having a void-free, homogeneous aluminum alloy material within contact holes in an insulating layer, in direct contact with [overlying] a substrate and having a nondeformed aluminum bridge over the contact holes, the semiconductor device structure formed by the method comprising:

depositing an aluminum material on an exposed surface of the insulating layer and over the contact holes;

heating the aluminum material to reflow the aluminum material into the contact holes so as to at least partially fill the contact holes;

applying pressure to the aluminum material to completely fill the contact holes;

depositing a different metal material on the aluminum material over the contact holes; and

diffusing the different metal material into the aluminum material to form a homogeneous aluminum alloy fill material in the contact holes and a nondeformed aluminum bridge over the contact holes.

23. (Twice amended) A semiconductor assembly having a void-free, homogeneous aluminum alloy material within contact holes in an insulating layer, in direct contact with [overlying] a substrate and having a nondeformed aluminum bridge over the contact holes, the semiconductor assembly formed by the method comprising:

providing a semiconductor substrate having an insulating layer overlying the semiconductor substrate, the insulating layer having contact holes formed therein;

simultaneously depositing and heating an aluminum material an on outer surface of the insulating layer and over the contact holes;

applying pressure to the aluminum material to completely fill the contact holes;

depositing a different metal material on the aluminum material; and

diffusing the different metal material into the aluminum material to form a substantially homogeneous void-free, aluminum alloy fill material in the contact holes and a nondeformed aluminum bridge over the contact holes.

39. (Twice amended) A semiconductor assembly having a void-free, aluminum-containing material within contact holes in an insulating layer, in direct contact with [overlying] a substrate and having a nondeformed aluminum bridge over the contact holes, the semiconductor assembly formed by the method comprising:

providing a semiconductor substrate having a dielectric layer overlying a semiconductor substrate, the insulating layer having contact holes extending therethrough;

filling the contact hole with a metal material including aluminum as a major constituent; and

modifying the characteristics of the metal material by diffusing at least a second metal material thereinto to form a void-free, homogeneous alloy fill material in the contact holes and a nondeformed aluminum bridge over the contact holes.